"The Menstruation and Ovulation of *Macacus rhesus*." By WALTER HEAPE, M.A., Trinity College, Cambridge. Communicated by Dr. M. FOSTER, Sec. R.S. Received June 15,—Read June 18, 1896.

(Abstract.)

The specimens used in the following investigation were collected in Calcutta in 1891.

Anatomy of the Cervix.—A valve-like structure is formed in the canal of the cervix by means of three strong folds, one of these folds fits into a recess formed by the two other folds, and forms a valve which persists throughout life. It is unlike any other structure of the cervix with which I am acquainted.

Breeding.—A definite breeding season for *Macacus rhesus* seems to be proved, but it is equally certain that in different parts of the Continent of India the breeding season occurs at different times of the year.

Menstruation.—A congestion of the skin of the abdomen, legs, and tail, a swelling and congestion of the nipples and vulva, and flushing of the face, are all prominent external signs of menstruation. A regular menstrual flow occurs consisting of a viscid, stringy, opaque white fluid filled with granules, and containing also red blood corpuscles, pieces of uterine tissue, both stroma and epithelium, and also leucocytes.

The following classification of the various stages passed through is adopted :—

A. Period of rest.	Stage I. The resting stage.
B. Period of growth.	Stage II. The growth of stroma.
	Stage III. The growth of vessels.
C. Period of degeneration.	
	Stage IV. The breaking down of vessels.
	Stage V. The formation of lacunæ.
	Stage VI. The rupture of lacunæ.
	Stage VII. The formation of the menstrual clot.
D. Period of recuperation.	
	Stage VIII. The recuperation stage.

The surface of the uterine mucosa, which is smooth and semi-transparent during Stage I, becomes swollen and opaque during Stage II, and flushed during Stage III ; it then becomes highly congested, Stage IV, and dark red spots, due to the formation of lacunæ, appear on the surface in Stage V ; when Stage VI is reached, free

blood is found in the uterine cavity; the menstrual clot is formed during Stage VII, and the torn mucosa is healed in the final, Stage VIII.

Histology.—The uterus consists of an internal mucosa and external muscular layers; the mucosa is composed of uterine and glandular epithelium, blood vessels, and stroma. The uterine epithelium lines the surface of the stroma, the glandular epithelium lines pits in the stroma and is continued into branches of those pits which extend from their lower end into the deeper part of the stroma.

The stroma itself is a delicate connective-tissue-like layer; the internuclear protoplasm is drawn out into delicate processes which form a continuous network, and there is no intercellular substance.

The histological changes which take place during the menstruation of *Macacus rhesus* are very similar to those which I have already described in a former paper, "The Menstruation of *Semnopithecus entellus* ('Roy. Soc. Proc.,' vol. 54, and 'Philosophical Transactions,' vol. 185). Work similar to that which I have already described for *S. entellus* has been undertaken for *Macacus rhesus*, and the phenomena compared step by step. While it has been thought advisable to note the points of similarity and of difference which occur in the menstruation of these two species, and to point out the fact that the results arrived at by the study of the menstruation of *Macacus rhesus* entirely confirm the results which my examination of *S. entellus* led me to publish, I have purposely avoided all unnecessary repetition and have been obliged in consequence to assume some knowledge of the details given in my former papers. It is all the more important to publish this account, as the results which I have arrived at differ in some important particulars from the accounts of menstruation which have been generally accepted.

Stage I.—The mucosa of *Macacus rhesus* is thicker and the protoplasmic network denser, the glands more numerous and more branched than is the case in *S. entellus*. I find no radial fibres.

Stage II.—There is a great increase in the number of nuclei by amitotic division and fragmentation. Hyperplasia occurs. The mucosa becomes much swollen.

Stage III.—The vessels increase in number and size, and they are congested. There is an increase of leucocytes.

Stage IV.—Hypertrophy of the walls of the vessels in the superficial part of the mucosa, followed by degeneration, occurs; the small vessels break down and extravasation of blood takes place. There is no sign of the migration of leucocytes.

Stage V.—Lacunæ are formed at first some distance below the epithelium, but they gradually displace the intervening tissue and come to lie directly below the uterine epithelium.

Stage VI.—The uterine epithelium degenerates and ruptures, and the blood contained in the lacunæ is poured into the uterine cavity.

Stage VII.—Denudation follows, and the formation of the mucosa menstrualis takes place in the same way and to the same extent as in *S. entellus*.

Stage VIII.—The recuperation takes place as in *S. entellus*. With regard to the new uterine epithelium I find fresh evidence in support of my contention that it is formed, not solely from epithelial elements which already exist, such as the torn edges of glands, but also directly from elements of the stroma tissue.

Ovulation in Macacus rhesus.—Only one case has been met with in which it can possibly be supposed that ovulation and menstruation have occurred simultaneously; this is the only case in which a recently discharged follicle was found in the ovary of a menstruating *Macacus rhesus;* it does not follow that ovulation in this case was brought about by menstruation; indeed, the absence of any sign of the recent bursting of a follicle in any other of the seventeen cases examined is in itself strong presumptive evidence that the two processes are distinct.

This result may be confidently asserted for *Macacus rhesus* during the non-breeding season; at the same time it must be remembered that I have not investigated *Macacus rhesus* during the pairing season; probably at that time ovulation may be more frequent, and may more often be coincident with menstruation; but, however that may be, menstruation occurs in *Macacus rhesus* regularly without ovulation taking place, and my former views are confirmed, namely, that ovulation does not necessarily occur during each menstrual period, and that it is not necessarily brought about by menstruation.

I feel warranted in going further than this and asserting that the regular occurrence of menstruation without ovulation, even though it be in the non-breeding season, is sufficient evidence that ovulation is a distinct process, and that it depends upon a law or laws other than the laws which govern menstruation.

The Discharged Follicle.—The changes undergone by the discharged follicles of *Macacus rhesus* during the non-breeding season are of interest. Very shortly after rupture the follicle is pear-shaped, and the place where rupture took place is to be seen in sections.

The wall of the follicle is composed of branched cells which, along the inner edge of the follicle, are longitudinally disposed and form a denser layer sharply defining the wall from the central cavity.

The cavity contains a network of densely granular material and no blood clot.

Hypertrophy now takes place, the wall becomes much thickened and folded, and a growth of cells takes place from the wall into the cavity of the follicle, the sharply marked boundary of the wall is lost, and the long protoplasmic processes of the cells within the cavity are continuous with the cells of the wall.

The vessels of the wall now become enlarged and increased in number. Hypertrophy is no longer evident; the tissue is denser and shrunken, and the whole structure is reduced in size. Gradually the cavity of the follicle is also reduced in size, and the tissue contained therein becomes denser until it is hardly to be distinguished from that composing the wall.

Finally the whole of the cellular remains of the follicle consist of a comparatively small mass of cells with no trace of the follicle wall and no central cavity, a nearly solid mass of tissue, in the midst of which a few blood vessels run. The cells which compose this mass now scarcely differ from the ovarian stroma cells; they have gradually undergone the change, and instead of branched cells they now appear as polyhedral cells or multinucleated polyhedral protoplasmic masses with intermediate finely branched connective tissue elements bounding them.

This structure is surrounded by a layer of fine nucleated fibres; but soon these disappear, and the remains of the follicle are no longer distinguishable from the rest of the ovarian stroma.

Throughout, no trace of a blood clot within the follicle was seen, and therein these ruptured follicles differ from what is usually described as a normal ruptured follicle in the human female. This difference between two animals, both of which undergo menstruation, is remarkable and worthy of special attention.

I have some reason to believe the difference may be due to the presence or absence of the breeding season in monkeys, and to periods in the human female, which are in the one case favourable, and in the other case not favourable, to conception.

If this be true, the period of the human female which is unfavourable to conception would be comparable to the non-breeding season of monkeys, and the period favourable to conception with the breeding season of monkeys.

It is not maintained that among civilised peoples at the present day there are definite breeding and non-breeding times, but the comparison is in harmony with the view that at one period of its existence the human species had a special breeding season.